

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:  
**Sparkes, Vernon W. et al.**

Confirmation No.: **1264**

Application No.: **10/595,982**

Group Art Unit: **3611**

International Filing Date: **December 6, 2004** Examiner: **Scharich, Marc A.**

For: **Pivoting Hitch Assembly**

**DECLARATION PURSUANT TO 37 CFR § 1.132**

Commissioner for Patents  
P. O. Box 1450  
Alexandria, VA 22313-1450

Sir:

I, Dr. William J. D. Shaw, declare as follows:

1. I am a citizen of the Canada, and currently reside at 53 Christie Gardens SW, Calgary, Alberta, T3H 3B5.
2. I received a B.Sc. from University of Saskatchewan in 1968; a M.Sc. from the University of Saskatchewan in 1972; and a Ph.D. from University of Saskatchewan in 1979.
3. I have extensive experience in the field of mechanical engineering and material science. I also have a great deal of experience in the field of "failure analysis." My working experience was first for Boeing where I conducted weights engineering on new aircraft and part of this required machine design of hydraulic actuators. Later I worked as a consulting engineer doing systems engineering design for mechanical systems in buildings. Following this I became involved in engineering failure analysis and this lasted over a 30 plus year stretch. Failure analysis involves determining the root cause of the failure and often analysis in order to prevent

the failure from occurring again. To this end, I am well versed in mechanical design, machine design, stress analysis, fatigue design and fracture mechanics, as well as metallurgy and fractography. I have taught classes on design (both undergrad and grad) to mechanical engineering students at the University of Calgary. See my curriculum vitae attached as Exhibit A.

4. I have also authored a number of publications on various engineering and technical topics. A list of my publications is provided as Exhibit B.

5. I am a co-inventor of the claimed subject matter of U.S. Patent Application Serial Number 10/595,982 ("the 982 application"). I have assigned all my rights, title and interests in and to the 982 application via written assignment to Mr. Vernon Sparkes, the other co-inventor listed on the 982 application.

6. I have been asked to provide this affidavit regarding the design, development, and prototype testing of the pivoting hitch assembly innovation, as well as, the outstanding rejection of the patent application for the Pivoting Hitch Assembly. I am not receiving any separate or additional compensation for my time spent in preparing this affidavit.

7. I have read and I am familiar with the 982 application and the description therein of the invention for the Pivoting Hitch Assembly. I have read and have a general understanding of the subject matter recited in the claims of the 982 application. I have also read and generally understand the proposed amendments to the claims being submitted along with my declaration.

8. It has been explained to me by our patent attorney, and it is my understanding, that the 982 application is currently pending before the United States Patent and Trademark Office (Patent Office) and that certain claims of the 982 application are currently rejected as being unpatentable as anticipated (i.e., not novel) and/or obvious in view of certain other patents.

9. As part of my review and assessment, I have read and I am familiar with the following references, including the description and figures of each reference, that I understand have been cited in the outstanding Office Action for the 982 application: U.S. Patent Application

Publication No. 2002/0140206 A1 issued to Lloyd; U.S. Patent No. 6,129,371 issued to Powell; and U.S. Patent No. 5,431,425 issued to Klinkman.

10. According to my reading and understanding of the 982 application, the application describes a hitch assembly that comprises a coupling tongue with a first clevis end and second clevis end; a substantially u-shaped clevis that is substantially flat in cross section (e.g., significantly wider than it is thick), and that is pivotally coupled to the second end of the coupling tongue by a hitch pin; and an opening formed by the coupling tongue and the u-shaped clevis, the opening sized to receive a towing member.

11. As noted above, I have been schooled, trained, and have work experience in the field of engineering. It is my opinion and experience that technicians and engineers in this field understand these general statements of other suggested materials by Powell and Klinkman, for example, are made as a general statement for either strength or weight saving. That is, technicians and engineers in this field would generally understand that steel materials are preferred for their high strength and aluminum materials for their lighter weight.

12. The problem being addressed, and the invention being claimed, in the 982 application is dynamic towing applications requiring high strength. In such applications targeting strength, aluminum alloys would not normally be selected or used. However, the behavior of this particular assembly configuration was tested out to show that the aluminum assembly results in an unexpected higher failure load than a similar dimensioned unit of steel. Standard engineering stress analysis predicts that the assembly constructed from steel will fail at a higher load than that for aluminum. In fact, the aluminum assembly (AA 6061-T6511) with material strengths 26% lower than the steel (AISI 1020) resulted in a maximum failure load 15% higher. This contradictory result was further analyzed and found to most likely be attributed to the redistribution of stresses to the pin as a result of the lower elastic modulus of the aluminum (greater extension of the aluminum components verses that of steel) and the alteration of the loading on the pin due to a tongue made from a solid bar of aluminum which changes the failure mode on the pin from that of 100% shear failure - as occurs in the steel assembly - to one of combined bending and shear in the aluminum assembly. The combined shear and bending

failure results in a higher load carrying capacity. These interactive changes of the specific material and configuration of the assembly were not expected nor predicable. Rather, the combination resulted in an unexpected outcome, making the aluminum assembly much better in performance than expected. This in turn resulted in multiple other advantages of: being able to use the aluminum assembly for higher loads; being lighter in weight; and not subject to corrosion and thus not requiring painting or other protective coatings. This phenomenon and unexpected result is disclosed in the detailed description of our patent application (see e.g., present application at page 7, lines 16-27; and page 9, lines 10-27).

13. For this high performance application the use of aluminum for the u-shaped clevis and/or coupling tongue material is counter-intuitive and would not normally be selected or used. Further, the unique combination of steel pins and aluminum u-shaped clevis (e.g., a solid, rectangular aluminum bar bent into a u-shape) and/or tongue fixture results in a distinct advantage over that of steel pins and steel fixtures (either solid or hollow). (*Id.*).

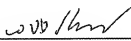
14. In my opinion, the Lloyd reference does not disclose the above features of the claims, including the u-shape clevis having a design that is wider than it is thick and hence substantially flat in cross section. Further, the Lloyd reference does not disclose the claimed combination of materials for the different components of the hitch assembly, which are recited in various dependent claims and new claim 22. According to my reading of the outstanding Office Action, the examiner examining the 982 application appears to agree with this latter belief (Office Action at pages 5-8). According to the Office Action, Lloyd . . . fails to specifically disclose: the hitch assembly (44) being entirely or partially comprised of aluminum alloy (Lloyd at pages 6 and 8); or the hitch pin being comprised of 4140 hot-rolled steel (Lloyd at page 7).

15. In my opinion, the Powell and Klinkman (and Lloyd) references, either alone or in combination, do not disclose the unique combination of materials for the hitch assembly components. While each includes a laundry list of possible materials, neither discloses any combination of steel and aluminum materials, for example, for the hitch pin and the u-shaped clevis and/or coupling tongue, respectively.

combination, do not disclose the unique combination of materials for the hitch assembly components. While each includes a laundry list of possible materials, neither discloses any combination of steel and aluminum materials, for example, for the hitch pin and the u-shaped clevis and/or coupling tongue, respectively.

16. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: Aug 26 / 10

  
Dr. William J. D. Shaw

**EXHIBIT “A”**

**OF DECLARATION OF  
DR. WILLIAM J.D. SHAW**

## **Curriculum Vitae**

current March 3, 2010

**SHAW, William John Douglas**, 65 years

**MAILING ADDRESS:** # 53 Christie Garden S.W.  
Calgary, Alberta, Canada, T3H 3B5

**OFFICE ADDRESS:** Department of Mechanical & Manufacturing Engineering  
The University of Calgary  
Calgary, Alberta, Canada, T2N 1N4  
phone (403) 220-5801 fax (403) 210-3440  
**e-mail:** wjshaw@ucalgary.ca

### **EDUCATION:**

Ph.D. Mechanical Engineering, University of Saskatchewan, 1979  
M.Sc. Mechanical Engineering, University of Saskatchewan, 1972  
B.Sc. Mechanical Engineering, University of Saskatchewan, 1968

### **EMPLOYMENT POSITIONS HELD:**

2003- 2008	Director, Pipeline Engineering Center, Schulich School of Engineering, The University of Calgary
1986- present	Professor, Dept. of Mechanical & Manufacturing Engineering, The University of Calgary
1981 - 1986	Associate Professor, Dept of Mech Engineering, The University of Calgary
1985- present	President, Materials Science Research Ltd., Calgary, Alberta
1977 - 1985	President, Shaw Engineering & Research Corporation, Saskatoon, Saskatchewan
1971 - 1981	Chief Mechanical Engineer/Partner, Angus Butler Engineering Ltd., Saskatoon, Saskatchewan

1971 - 1972	Departmental Assistant, Dept of Mechanical Engineering, University of Saskatchewan Saskatoon, Saskatchewan
1968 - 1969	Associate Engineer, The Boeing Co., Renton, Washington, U.S.A.
1964 - 1965	Engineer Aide, The City of North Battleford, North Battleford, Saskatchewan

#### **PROFESSIONAL ASSOCIATIONS:**

APEGGA	Association of Professional Engineers, Geologists and and Geophysicists of Alberta
AWS	American Welding Society
ASM	ASM International
IMS	International Metallographic Society
NACE	National Association of Corrosion Engineers
TMS-AIME	The Metallurgical Society
ASTM	American Society for Testing Materials
ACS	American Chemical Society

#### **ADMINISTRATION EXPERIENCE:**

Director, Pipeline Engineering Center, 4.5 years: Co-ordination of education and research between University and Industry, promotion of pipeline engineering research and dissemination of knowledge. Developing courses and establishing a balanced graduate program in pipeline engineering. Working towards making the Center self supporting, conducting service contracts to the industry.

10 years in Consulting Engineering as Partner and Chief Mechanical Engineer of Angus Butler Engineering, Saskatoon. Shared in more than half of the administration of a staff of 12, my partner was an electrical engineer. Supervised entire mechanical systems design, procurement and site supervision. Full responsibility for the mechanical systems in all designs , including all aspects of every project. Responsibility for negotiations and dialogue with owners, architects, government agents and contractors. Within office, normally supervised one secretary and 8



technicians directly beneath my responsibility. This included hiring, training and firing.

Toastmasters administrative roles: President, Educational Vice-President, Administration Vice-President and Secretary.

International Metallographic Society: Treasurer, Co-Chairman of 1988 IMS Exhibit.

Professor U of C: directing a Materials Group of at one time consisting of 20 personnel directly under my control. Group consisted of graduate students, technicians, engineers, visiting professors, post-doctoral fellows and visiting scholars.

Professor U of C: Chairman Student Appeals Committee for two years, member of Faculty of Graduate Studies Scholarship Committee, member of General Faculties Counsel, ex-officio member of Faculty of Science, ex-officio member of Faculty of Education. Chairman of Materials Committee in Department of Mechanical Engineering. Over the years, served on many other committees at the Department and Faculty level.

Consultant: Technical Mediator for the Government of British Columbia between BC Hydro and WestCoast Energy. Dispute on lightening mitigation beside a substation in Sechelt, B.C.

## **TEACHING EXPERIENCE (University of Calgary)**

### Lectures

ENGG 225	- Engineering Design and Graphics
ENME 421	- Materials I (Basic Materials Science)
ENME 521	- Materials II (Mechanical Metallurgy)
ENME 661	- Corrosion Science
ENME 667	- Fracture Mechanics
ENME 669	- Fatigue of Materials
ENME 665	- Mechanical Behaviour of Materials
ENME 619.45	- Welding Metallurgy and Design
ENME 619.23	- Failure Analysis
ENME 619.74	- Materials Selection in Engineering Design and
ENME 619.84	- Experimental Methods in Materials Science
ENPE 563	- Materials Aspects of Petroleum Engineering
ENME 619.16	- Corrosion Science in the Pipelines Industry
ENME 619.42	- Mechanical and Materials Engineering Design
ENME 619.55	- Development of Pipeline Integrity Management Programs

### Reading Classes

ENME 519.07	- Mechanical Metallurgy
ENME 663	- Applied Corrosion Science
ENME 619.43	- High Temperature Deformation of Materials
ENME 619.41	- High Strength Material Composites
ENME 619.94	- Damage Mechanisms in Fatigue

	ENME 619.07	- Advanced Polymeric Alloys and Blends
	ENME 619.08	- Mechanically Alloyed Materials
	ENME 619.90	- Stress Corrosion Cracking Behaviour of Materials
	ENME 619.96	- Current Understanding of NiMH Alloy Materials
	ENME 619.50	- General Aspects of Hydrogen Embrittlement
	ENME 619.16	- Hydrogen Diffusivity
	ENME 619.02	- Cryogenic Effects on Materials
<u>Project Class</u>	ENME 535	- Mechanical Engineering Project
<u>Tutorials &amp; Labs</u>	ENGG 209	- Engineering Economics
	ENME 493	- Machine Component Design
	ENGG 201	- Behaviour of Liquids, Gases and Solids
	ENME 421	- Basic Materials Science
	ENME 521	- Applied Materials Science
<u>Major Seminars</u>		- Pipeline Materials, Integrity and Understanding
		- Selection of Materials for Pipelines
		- Making Effective Technical Presentations
		- Theory and Design of Industrial Pressure Components

#### COMMUNICATION SKILLS:

Toastmaster 4 yrs., completed communication and leadership manual, awarded competent toastmaster award (CTM). Served as President, Educational Vice-president, Administrative Vice-president, and Secretary within clubs.

Judge for student speech contest, sponsored by Engineering Student Society, 1983.

Tutor, Effective Technical Presentations, Faculty of Continuing Education and APEGGA sponsored course, 1983.

#### INTERNATIONAL INVOLVEMENTS:

Reviewer - Applied Mechanics Reviews, ASTM, CSME, ASME, Int. J. of fatigue, Materials Research Bulletin, J. of Corrosion, NSERC, IPC.

Chairman of Student Papers for IPC 2008

Chairman of Educational Seminar of IPC 2008

Co-chairman International Metallographic Exhibit Committee for 1983 Summer Meeting

Chairman, Finance Committee, International Metallographic Exhibit, 1986-1991

Treasurer - International Metallographic Society, 1991-1993

Financial Officer - International Metallographic Society, 1993-1995

Member - Canadian Committee for Research on the Strength and Fracture of Materials

**STUDENTS SUPERVISED:**

- G. Beaton (4th Yr Project) - Effect of Fire on the Mechanical and
- D. Caswell (4th Yr Project) - Heat Treatment and Microstructural Control of
- B. Palmer (4th Yr Project) - Development of a Memory Metal Heat Engine
- K. Engler (4th Yr Project) - Effect of Cryogenic Treatment on Tool Steel
- M. Pankiw (4th Yr Project) - Corrosion of Aluminum Alloy in Mercury
- R. Sahney (4th Yr Project) - Analysis of Cracking in Pressure Vessels
- M. Sutherland (4th Yr Project) - Design of a Large Vacuum Chamber
- T. Hassan (4th Yr Project) - Electrochemical and Galvanic Behaviour of Inorganic Zinc Coatings
- B. Clifford (4th Yr Project) - Evaluation of Pipeline Corrosion Risk Assessment Model
- R. Thom (M.Sc.) - Fracture Toughness Degradation Due to Over Cathodic Corrosion
- K. Gill (M.Sc.) - Soil Conductivity Measurement for Corrosion Design
- P. Ho (M.Sc.) - Creep and Environmental Creep of a Substitutional Stainless Steel Alloy
- S. Porter (M.Sc.) - Stress Intensity Factors for Unsymmetrical Cracks
- R. Candadai (M.Eng.) - Materials Science, corrosion
- A. Bandali (M.Eng.) - Well Water Corrosivity on Casing Materials
- C. Woo (M.Sc.) - Finite Element Methods for Evaluating Stress Intensity Factors
- G. Ng (M.Eng.) - Fracture Mechanics Applied to Compressive Fatigue Loading
- X. Le (M.Sc.) - Single Fibre Strengths of Carbon Fibres for Composite Materials
- K. Rattan (M.Sc.) - 3-D Photoelastic Simulation Studies of Composite Material
- J. Staniland (M.Sc.) - Single Fibre Pullout Strengths from Epoxy Composite Matrix

- D. Jayasinghe (M.Sc.) - Electrochemical Corrosion Behaviour of Materials in Coal Gasification Environments
- T. Sterner (M.Sc.) - Stress Corrosion Cracking Studies and Comparison of Testing Techniques
- J. Klotz (M.Eng.) - Materials Science
- H. Huang (Ph.D.) - Stress Corrosion of Steel in Sour Environments
- H. Danilukewich (M.Sc.) - Development of Conductive Polymers
- D. Diakow (M.Sc.) - Stress Corrosion Cracking as Effected by Specimen Geometry
- A. Depiak (M.Sc.) - Cryogenic Treatment Effect on Materials
- C. Sun (Ph.D.) - Interference Shrink Fit Buckling Geometry
- T. Nijjar (M.Eng.) - Overaging Effects on Fatigue Life of Aluminum Alloys
- D. Horsley (M.Eng.) - Hot Tap Tee Evaluations on Large Size Pipelines
- I. Gunea (M.Sc.) - Investigations into Microsuperplasticity
- J. Pan (Ph.D.) - Mechanically Alloyed Polymeric Materials
- X. Zhu (Ph.D.) - Shotpeening and Fatigue of Aluminum Alloys
- S. Hooper (M.Sc.) - Galvanic Effects on Stress Corrosion Cracking
- D. Milicevec (M.Eng.) - New Battery Material Evaluations
- D.G. Matei (M.Sc.) - Vacuum Foil Hydrogen Permeation Measurements
- M. Rubat Du Merac (M.Sc.) - Cryogenic Effects on Materials
- K. Widenmaier (M.Eng.) - Robust Materials Methods in Creep of Steels
- Y. Pan (M.Sc.) - Spheroidizing of steel
- G. Mesar (M.Eng.) - Diffusion Welding of Aluminum Alloys
- T. Senadheera (M.Sc.) - Grain Refinement of Cast Aluminum Alloys
- J. Ma (M.Eng.) - 316 Stainless Steel Stress Corrosion Cracking Behavior

C. Dai (M.Eng.)	- Determination of exchange current densities for steels
E. Wu (M.Sc.)	- Strain Aging Kinetics of X100 Pipeline Steel
Y. Yu (M.Eng.)	- Robust Materials Methods of Fracture Toughness in Steels
M. Farrokhazd (M.Sc.)	- Correlations of Direct and Indirect Hydrogen Measurement in Steel
M. Schwarz (Ph.D.)	- Pipeline Mill Scale Effects on Corrosion
T. Senadheera (Ph.D.)	- Measurement Methods of Hydrogen in Steel
E. Cruz (Ph.D.)	- Pipeline Velocity Effects on Corrosion
T. Eggum (Ph.D.)	- SCC of Pipeline Steels

#### **POST DOCTORATES SUPERVISED:**

R. Ramesh	2006- present	- Fuel cell material synthesis using mechanical Alloying - Evaluation of Speed rivets and Speed Rivet Gun
I. Dunmade	2005- present	- Natural composite material evaluations
M.S. Salama	1993-2000	-Wear relations of cryogenic treated materials Mechanical ball mill simulation studies
S.R. Alam	1993-1995	- Hydrogen embrittlement & hydrogen measurement
M. Ghobrial	1990-1994	- Elastic-Plastic Indentation Studies Using Finite Elements
M.S. Kozdras	1992-1993	- Electroplating and Electrochemical Reactions
M. El Rahman	1989-1991 2000-present	- 3-D Composite Stress/Strain Analysis Using - Finite Elements Applied to Materials

#### **VISITING SCHOLARS SUPERVISED:**

S. Hu	2000- 2001, China	- Microsuperplasticity and Superplasticity Studies
F. Laing	1992-1993, China	-Pitting Corrosion Studies

M. Kuhn	Summer 1992, France	-Microsuperplastic Studies
W. Zhao	1988-1989, China	- Back Face Strain Calibration for Fatigue and Fracture Work
M. Videm	1989-1990, Norway	- Fatigue of Aluminum
Z. Yang	1989-1990, China	-Strain-Life Fatigue of Al Alloys
C. Xing	1989-1990, China	- Heat Treatments of Fe-Mn-Al Steel
C. Ni	1989-1990, China	- Small Specimens and Material Properties

#### **TECHNICAL ASSOCIATES SUPERVISED:**

D. M. Jayasinghe	1997-1999	- Technical Project Manager, various projects
D. Jayasinghe	1990-1991	- Corrosion studies of Aluminum & Methanol
M. Sutherland	1989-1992	- Design of Mechanical Alloying equipment

#### **TECHNICAL ASSISTANTS SUPERVISED:**

M.A. Fraser	1992-present	- Technical laboratory support, electron microscopes
T. LeBlanc	1994-1998	- Hydrogen embrittlement studies
A. Bizon	1994-1997	- Hydrogen embrittlement studies
K. Sunderset	Summer 1993	- Microsuperplasticity studies
A. Somers	1991-1992	- Technical laboratory support

#### **SEMINARS PRESENTED (Mainly External to University):**

Shaw, W.J.D. and Seshadri, R, "Theory and Design of Industrial Pressure Components", Memorial University, St. John's Newfoundland, Oct 2-4, 1996.

Shaw, W.J.D., "Corrosion Science", Syncrude, Fort McMurray Alberta, Jan - April, 1993.

Shaw, W.J.D. and Seshadri, R, "Theory and Design of Industrial Pressure Components",

Materials Science Research Ltd, Calgary Alberta, June 3-5, 1991.

Shaw, W.J.D. and Seshadri, R, "Theory and Design of Industrial Pressure Components", Syncrude, Fort McMurray Alberta, June 5-7, 1989.

Shaw, W.J.D. and Seshadri, R, "Theory and Design of Industrial Pressure Components", University of Calgary, Calgary Alberta, June 24-26, 1987.

#### **AWARDS:**

**2009 Service Excellence Award**, awarded to Faculty members who have provided exceptional Department, Faculty or University leadership, Schulich School of Engineering. For work in establishing the Pipeline Engineering Center.

**2007 Excellence in Teaching** and Displaying Enthusiasm for Engineering to Students.

**2003 Killam Resident Fellowship**, writing a textbook on Mechanical Behavior of Materials.

**2002 Professor of the Year, Outstanding Education Award**, The Engineering Students' Society of The University of Calgary, for The Department of Mechanical Engineering.

**2001 Professor of the Year**, Mechanical engineering Students Society, University of Calgary

**2001 Teaching Excellence Award**, The Engineering Students' Society of The University of Calgary, for The Department of Mechanical Engineering.

**2000 Honorable Mention Teaching Excellence Award**, The students Union, The University of Calgary, for The Faculty of Engineering.

**1998 Van Horne Fellowship**, conducting research on Hydrogen Embrittlement

**1996 Teaching Excellence Award**, The Engineering Students' Society of The University of Calgary, for The Department of Mechanical Engineering.

**1994 Teaching Excellence Award**, The Engineering Students' Society of The University of Calgary, for The Department of Mechanical Engineering.

#### **International Metallographic Society Contest**

1st prize, 1986 Metallographic Exhibit, Class 6, Scanning Electron Microscopy Entry entitled "Microsuperplastic Phenomena in Mechanically Alloyed Aluminum"

#### **CURRENT AREAS OF RESEARCH INTEREST:**

Mechanical Alloying

Design, Research and Development

Electrochemical Corrosion  
Hydrogen Embrittlement  
Fracture Mechanics  
Mechanical Testing  
Fractography  
Microsuperplasticity  
Creep  
Polymeric Materials  
Memory Alloys  
Soldering Technology  
Computer Simulation  
Strain Aging

Stress Corrosion Cracking  
Failure Analysis  
Fatigue  
Materials Characterization  
Material Selection  
Metallography and Metallurgy  
High Strength Composite Materials  
Ceramic Materials  
Welding Metallurgy  
Mechanical Engineering Design  
Robust Methods in Materials Science  
Atmospheric Corrosion

**HOBBIES:**

Metal machining and welding (design/build), motorcycling, canoeing, camping, wine making, learning Spanish as a second language.



## C.V. OVERVIEW

Prior to joining the University of Calgary, Dr. Shaw acquired 12 years of industrial experience of which 10 years were spent in consulting engineering. The operation of Shaw Engineering and Research Corporation was involved primarily with materials engineering consulting along with fracture mechanics and failure analysis of various components. Additionally some product development work was also undertaken for private industry as well as some project management of renovations to the mechanical systems in a large building.

Involvement with Angus Butler Engineering Ltd., which at the time was a mechanical and electrical consulting engineering firm employing 14 people, consisted of overseeing the complete mechanical engineering aspects of all projects. This entailed client liaison through complete design, compiling specifications through to supervision of the construction for the project. The annual work load amounted to approximately \$4.5 million/year in construction costs of the mechanical systems based on 1980 monetary value. The type of buildings ranged from small custom designed houses to large high rises, shopping centres, schools, skating rinks and hospitals. For a time while directing the mechanical consulting activity for Angus Butler Engineering, Ph.D. studies were undertaken simultaneously.

The position of Departmental Assistant with the University of Saskatchewan was one of involvement within the fluid mechanics and thermodynamics laboratories, both as an instructor within the labs and also responsible for the operation of the entire laboratory.

Experience with Boeing Aircraft Company was in the area of weights engineering for flight controls, electrical and electronic systems of a new aircraft development. The aircraft from that program has now evolved into the Boeing 767.

The City of North Battleford provided training in the areas of surveying, drafting and design of sewer, water, storm sewer and curb and sidewalk.

Consulting, design, managing people and projects in the past, prior to joining the University of Calgary, was challenging and rewarding. Later, teaching combined with research investigation held excitement and challenge to a higher degree than the involvement of a building or the solution to a problem where the basic equations and principles were known.

Teaching at both the undergraduate and graduate level is stimulating and exciting, mainly in the reactions induced to young minds as they are being challenged academically.

Involvement with the research work at the University of Calgary has spanned a wide variety of grants and contracts over the years covering many different areas of Material Science. Some of the areas that have been investigated were high temperature creep behaviour of a new substitute stainless steel, high temperature creep crack growth rate in aluminum alloys, new methods of evaluating stress corrosion cracking susceptibility of materials, fatigue crack closure and prediction methods for safe life designs, degradation of materials exposed to sour crude oil environments, determinations of stress intensity factors for various component configurations, shear measurements and determinations of mechanical strengths in high strength carbon epoxy fibre composites, development of new methods in failure analysis investigations, development and measurement techniques for assessing hydrogen in materials, electrochemical screening of inhibitors in sour  $H_2S/CO_2$  environments, development of predictive methods for assessing the corrosivity of well waters, parameters involved with optimizing diffusion welding of materials, investigation of the characteristics of mechanically alloyed aluminum. Most of the projects are concerned with environmental interaction on the mechanical properties of materials but an integrated approach using mechanical engineering, metallurgy and general material science is applied.

During the course of a number of years a total of four new failure mechanisms have been discovered and analysed. These are: "delamination cracking", "shear ridges", "microsuperplasticity" and "stress striations". Other exciting work has been the discovery of the oxygen evolution reaction in mechanically alloyed aluminum. The most significant and important work conducted has been the development of mechanically alloyed polymeric materials which opens up unlimited permutations of alloys of polymer/metal/ceramic. More recently the development of an new area coined "Robust Materials Methods", has evolved. This grew out of analysis work on true stress and true strain and its application in superplasticity. The analysis was a direct result of writing a textbook in Materials Design. This Robust Materials Methods area is an exciting area which has a major use in industry, particularly in establishing material properties in aged plants and structures. This area is where most of the research activity is now directed.

Writing of a textbook in the area of mechanical behavior of materials has been a major creative endeavour. It incorporates many new innovations in a number of applied areas and should be a foundation book for many years to come. It will make publication in the Winter of 2009.

Establishing the Pipeline Engineering Center, PEC, provided considerable challenge over a four and a half year period. Developing the graduate program, establishing a wide variety of graduate classes, providing pipeline engineering consulting to the industry, establishing short professional courses and building research in pipeline engineering, as well as establishing monetary viability of the Center was an exciting and demanding project and period of time.

## CONSULTING PROJECTS CONDUCTED:

Expert on Corrosion of Alaska BP failure	State of Alaska	2010
Evaluation of Efficient Directional Drilling	Newsco	2010
Pitting of steel Elbows Evaluation	CEDA	2009
Mobile Home Fire Evaluation	Hansen & Associate	2009
Vehicle Tie Rod Failure Analysis	Mills	2009
Glycol Corrosion Induced Failure	Borden, Ladner Gervais	2009
Water Truck Drive Axel Failure Analysis	Smallman	2009
Atmospheric Corrosion Study	Husky Oil	2008
Truck Wheel Rim Failure Analysis	Krepps	2008
Evaluation of Directional Drilling System	Mostar	2007
Pipeline Benchmark Study	Mexico, IMP/PEMEX	2006
Support on Sable Island Corrosion	Fraser, Milner, Casgrain	2006
Fatigue Design of DehCho Bridge, NWT	J. Sprocken	2005
Lubricator Stub Failure Investigation	Kismet Engineering	2005
Coiled Pipe HIC Testing	BJ Services	2005
Corrosion Materials Screening	Orion Oil	2004
Support on SCC Heat Exchanger Cracking	Fraser, Milner, Casgrain	2004
Avalanche Transponder Failure Evaluation	Cornor's Office, Nelson, BC	2004
Throttle Mechanism Evaluation	Yamaha	2004
Large Impact Hammer Failure Investigation	Polaris	2004
Design, Testing and Analysis of Truck Hitch	Tugkco	2004
Pressure Vessel Engineering Safety Audit	Alberta Research Council	2004
Analysis of Curvature in Converter Vessels	Central Alberta Midstream	2003
Properties of an Aged 304 SS Welded Duct	PetroCanada Refinery	2003
Mechanical Properties of Extrusion Mg Alloys	Thixotech Inc.	2003
Fracture Mechanics Analysis of a Component	Coax Technology Inc.	2003
Impact Properties of Ceramics	Ceramic Protection Corp	2002
Material Control of Processing Parameters	SMED	2002
Manifold Material Evaluations	Alternate Fuel Systems	2002
Ceramic Materials Evaluation	Ceramic Protection Corp	2001
Evaluation of Diamond Properties	SP3 Ltd	2001
Material Property Determinations	TCPL	2001
Adhesion Evaluation of Floor Panels	SMED	2001
Fatigue Thresholds in Pipe Fittings	Perto-Line	2001
Analysis & Design of Portable Structure	M&M Meats	2001
A/C Corrosion Investigation	Neopgg Ltd	2000
Volkswagon Seat Belt Degradation Analysis	Samac Engineering	2000
Investigation of Gasoline Distribution Line	United Farmers Association	2000
Drive Shaft Fatigue Failure Analysis	Beta Machinery	2000
Pipe Failure Analysis	Enercon companies	2000
Turbine Blade Evaluation	Nova	1999
Electrolytic Cell Parameters	Hyburn Inc	1998
Cryogenic Treatments of Steels	Integrated Cryogenics	1998

Coating Evaluations	International Utility Structures	1998
Pressure Vessel Failure Investigation	Banner Phamacaps	1998
Cable Corrosion Evaluation	Transgas	1998
Evaluation of Instrumentation Cable	Transgas	1997
Fireline Corrosion Failure Analysis	TransAlta	1997
Pipeline Discharge Temperature Analysis	Milner Fenerty	1997
Evaluation of High Pressure Heaters	Newfoundland & Labrador Hydro	1997
Corrosion Evaluation of Materials for Hog Barns	New World Housing	1996
Definitions of Corrosion & Hydrogen Embrittlement	Foothills Pipe Lines	1996
Safety Aspects of New Pressure Vessels	Artic Offshore Engineering Ltd	1996
Mechanical Alloyed Polymers	Hoechst Celanese	1996
Fatigue Testing of cables	Northern Telecom	1996
Adhesion of New Inorganic Zinc Coatings	International Utility Structures	1996
Evaluation of Canusa Pipe Sleeve	Allan Nelson Engineering	1995
Fractographic Evaluation of HIC Fracture	Foothills Pipe Lines	1995
Temperature Tests on Electronic Equipment	Galvanic Analytical Systems	1995
Sandblast Effects on Coating Adhesion	International Utility Structures	1995
Roller Bearings Comparison	Kenn Borek Limited	1995
Ski Shaving Material Analysis	Parlee McLaws	1995
Steel Rust Evaluation	International Utility Structures	1995
Adjusting Breakpoint Assembly	Downhole Systems Technology	1995
Coke Report Study	Canada Metal	1995
Gas Flow Erosion Report	Novacor	1994
Panel Tests & Evaluation	BCM Manufacturing Ltd	1994
Coating Thickness Calibration	International Utility Structures	1994
Coating Surface Preparation Method	International Utility Structures	1994
Utility Pole Coating Evaluation	International Utility Structures	1994
Diamond Drill Evaluation	Dy-Drill Inc	1994
Swing Bolt Closure Evaluation	APPEGA	1994
Power Cable Jack Testing	Novatel Communications	1993
Screw Pull Out Strengths	University of Calgary	1993
Gold Separator Evaluation	D. Besler	1993
Dental Office Fire Failure Investigation	Cook Snowdon Barristers	1993
Tee Defect Failure Investigation	Co-op Refinery Upgrader	1993
Accumulator Tank Failure Analysis	ECE Group Ltd	1993
Down Hole Sub Failure Analysis	Placid Oil	1993
Teaching Corrosion Science Class	Syncrude Canada Ltd	1993
Lightning/Pipeline Dispute Arbitration	Province of British Columbia	1993
High Temperature Material Behaviour	Nova Corporation	1993
Telephone Keypad Mechanical behaviour	Novatel Communications	1993
Heat Exchanger Failure Analysis	Sask Power Corporation	1993
Hydrogen/Material Interaction Review	Canadian Gas Association	1992
Adhesive Peel Testing	Charter Coating Service Ltd	1992
Needle Valve Evaluation	Melaar Resource Ltd	1992
Evaluation of O-ring Design	Computer Sonic Systems	1992

High Temperature Material Response	Nova Corporation	1992
Fatigue Testing of Water Filters	Mountain Fresh Canada Ltd	1992
Foam Evaluation	Stephen Garry Ney Barrister	1992
Automotive Tire Jacks Evaluation	Taylor & Company	1992
Tire Failure Investigation	Schick & Company Adjustors	1992
Netting Strength Testing	Canadian Olympic Park	1992
Load Cell Calibrations	Tri-Ener-Tech	1992
Pressure Vessel Design Seminar	Various Manufactures	1991
Propane Fire Investigation	Brouwer Claims Canada	1991
Valve Failure Investigation	MacKimmie Matthews	1991
Scientific Tax Credit Investigations	Federal Dept of Justice	1990
Speaker Failure Investigation	NovAtel Communications	1990
Hardness Evaluation of Steel Part	Omega Sheet Metal Ltd	1990
Polymer Coatings Evaluation	Boetec Consultants Ltd	1990
Beverage Container Assessment	Blackwoods Beverages Ltd	1990
Ladder Failure Investigation	MacPhail & Cowper-Smith	1990
Thermal Conductivity of Ceramic	Ram Resources	1990
Boiler Creep Evaluation	Imperial Oil	1990
Heat Exchanger Corrosion	Flieshmann's	1990
Fabric Tests and Evaluation	Petro Canada	1989
Bolt Failure Investigation	Fluor Daniel	1989
Fan Shaft Failure Investigation	Paramount Resources	1989
Heat Exchanger Investigation	Western Natural Gas	1989
Axel Failure Analysis	U of C Maintenance Department	1989
Bicycle Spoke Failure Investigation	McLeod Lyle	1988
Failure Analysis of Connecting Rod	Alta Gas and Chemicals	1988
Certification of Manlift	Tyrrell Museum	1988
Fatigue Evaluation of Wire	Novatel Communications	1988
Connector Humidity Testing	Novatel Communications	1988
Bearing Failure Analysis	United Canso Oil & Gas	1988
Fire pipe examination	Norcen Energy Resources	1988
Pipe Failure Analysis	Paramount Resources	1987
Bearing Race Failure Analysis	Paramount Resources	1987
Babbitt Bearing Failure Analysis	Paramount Resources	1987
Pump Redesign & Repair Method	PanCanadian Petroleum	1987
Structural Bolt Evaluation & Specs	Con-Force Structures	1987
Corrosion Studies of Plate Mtl.	Det Norske Veritas	1986
Trunnion Shaft Investigation	Canadian Fertilizers Ltd.	1986
Diesel Crankshaft Failure Analysis	Lethbridge Diesel Ltd.	1986
Corroded Impeller Investigation	Co-Enerco	1986
Tests on Flexible Connectors	Magi-Span Fabrication	1986
Tests on Scottford Flange	Shell Canada Resources	1986
Testing of Brackets	Engineered Air	1986
Low Temperature Tensile Tests	Petro-Canada Resources	1986
Testing Strain Gauged Rubber Bearing	Artec Canada Ltd.	1986

Adhesive Tests	Gulf Canada Corp.	1986
Materials for Hydrogen Storage	RTM Engineering Ltd.	1985
Loading Dock Aluminum Plates	Canada Post	1985
Hydraulic Cylinder Failure	Canadian Fertilizer	1985
Walker Motor Vehicle Accident	Scott & Thomas	1985
Evaluation of Aircraft Seat Belts	Keith & Assoc.	1985
Autoclave Failure Analysis	Civil Eng. U of C	1985
Turbine Pin Analysis	Alta Gas & Chemical	1984
Heat Treating Line Analysis	IPSCO	1984
Weak Point Testing	Schlumberger	1984
Tensile Tests of Welds	ESSO Resources	1984
1983 Subaru Bearing Failure	Select Auto	1984
Plastic Key Pad Evaluation	Northern Telecom	1983
ABAX Wind Turbine Mtls/Fatigue Design	ABAX	1983
Fatigue Tests on Cable Ties	Synchrude	1983
Evaluation of Arc Damaged Motor	Sask. Gov't Insur.	1983
Foam and Adhesive Tests	Dome Petroleum	1983
Blower Failure Analysis	Keho	1983
Electron Fractography of Failure	Shell Canada	1982
Sewer Pipe Failure	James & Piechel	1982
Elastomer Testing	Canadian Formost	1982
Propeller Shaft Bolt Failure	Dome Petroleum	1982
Rigid Foam Testing	Dome Petroleum	1982
Drill Pipe Failure Analysis	Petro-Canada	1981
Stress Analysis of Blower Impeller	Keho	1981
Heat Exchanger Failure Evaluation	Metallurgical Services	1981
Arc Damaged Motor Evaluation	SGI	1981
Fire Affected Carburettor Evaluation	SGI	1981
Trailer Car Accident	SGI	1981
Tandem Rear Drive Axel	SGI	1981
Roller Rink Roof Top Fire	Stinson & Eisler	1981
Grader Material Evaluation	SGI	1981
Evaluation of Welding Test Specimens	Great West Steel	1981
Boiler Fire Tube Failure Analysis	Consolidated Engineering	1981
Sprinkler Tee Fitting Failure Analysis	Consolidated Engineering	1981
High Boy Axel Failure	Valley Farms	1981
House Furnace Investigation	Stinson & Eisler	1981

**EXHIBIT “B**

**OF DECLARATION OF  
DR. WILLIAM J.D. SHAW**

## PUBLICATIONS:

updated March 3, 2010

JOURNAL PUBLICATIONS:

1. Senadheera, T.A.A. and **Shaw**, W.J.D., "*Improvements in the Mercury Displacement method for Measuring Diffusible Hydrogen Contents in Steels*", J of Testing and Evaluation, 2009, V37, N3, pp. 1-8.
  2. **Shaw**, W.J.D., Gunee I.A. and Kuhn, M., "*Modelling of Microsuperplasticity in Mechanically Alloyed Aluminum*", International Journal of Fracture, 1999, V97, pp. 103-111.
  3. Gavrilov, D., Vinogradov, O. and **Shaw**, W.J.D., "*Simulation of Grinding in a Shaker Ball Mill*", Power Technology, 1999, V101, pp. 63-72.
  4. Zhu, X.Y. and **Shaw**, W.J.D., "*Fatigue Crack Closure and its Effect on Life Prediction in Compact Tension Specimens*", International Journal of Fatigue, 1996, V18, N7, pp. 499-505.
  5. Sun, C., **Shaw**, W.J.D. and Vinogradov, A.M., "*Instability of Confined Rings: An Experimental Approach*", Experimental Mechanics, 1995, V35, N2, pp. 97-103.
  6. Zhu, X.Y. and **Shaw**, W.J.D., "*Correlation of Fatigue Crack Growth Behaviour With Crack Closure in Peened Specimens*", Fatigue & Fracture of Engineering Materials & Structures, 1995, V18, pp. 811-820.
  7. Pan, J. and **Shaw**, W.J.D., "*Effects of Processing Parameters on Material Properties of Mechanically Processed Polyamide*", J. of Applied Polymer Science, 1995, V56, pp. 557-566.
  8. Sun, C., **Shaw**, W.J.D. and Vinogradov, A.M., "*One Way Buckling of Circular Rings Confined by a Rigid Boundary*", J. of Pressure Vessel Technology, ASME, 1995, V117, pp. 162-169.
  9. Sun, C., **Shaw**, W.J.D. and Vinogradov, A.M., "*Discrete Element Model for Buckling Analysis of Thin Ring Confined Within Rigid Boundary*", J. of Engineering Mechanics, 1995, V121, N1, pp. 71-79.
- Huang, H. and **Shaw**, W.J.D., "*Effect of Cold Working on the Fracture Characteristics of Mild Steel Exposed to a Sour Gas Environment*", Materials Characterization, 1995, V34, pp. 43-50.



10. Huang, H. and **Shaw**, W.J.D., "*Microstructural Corrosion Behavior of Cold Worked Steel in a Sour Environment*", *Materials Characterization*, 1995, V34, pp. 35-41.
11. Huang, H. and **Shaw**, W.J.D., "*Hydrogen Embrittlement Interactions in Cold Worked Steel*", *Corrosion*, 1995, V51, N1, pp. 30-36.
12. **Shaw**, W.J.D. and Zhao, W. "*Back Face Strain Calibration for Crack Length Measurements*", *J. of Testing & Evaluation*, 1994, V22, N6, pp. 512-516.
13. **Shaw**, W.J.D., "*Failure Analysis and Material Property Determinations of Small Diameter Wires*", *Materials Characterization*, 1994, V33, N1, pp. 57-63.
14. Pan, J. and **Shaw**, W.J.D., "*Properties of a Mechanically Processed Polymeric Material*", *J. of Applied Polymer Science*, 1994, V52, pp. 507-514.
15. Zhu, X.Y., Li, Z., Jin, X., and **Shaw**, W.J.D., "*Creep Behaviour of Hybrid Fibre (glass/carbon) Reinforced Composite and It's Application*", *Composites Science & Technology*, 1994, V50, pp. 431-439.
16. Huang, H. and **Shaw**, W.J.D., "*Cold Work Effects on Sulfide Stress Cracking of Pipeline Steel Exposed to Sour Environments*", *J. Corrosion Science*, 1993, V34, pp. 61-78.
17. Huang, H. and **Shaw**, W.J.D., "*Sulfide Stress Cracking Fractography of Mild Steel and Effects of Cold Work*", *Canadian Metallurgical Quarterly*, 1993, V32, pp. 341-349.
18. Huang, H. and **Shaw**, W.J.D., "*Electrochemical Aspects of Cold Work Effect on Corrosion of Mild Steel in Sour Gas Environments*", *Corrosion*, 1992, V48, pp. 931-939.
19. El-Rahman, M.A. and **Shaw**, W.J.D., "*La Informatica en la Tecnologia del Concreto*", *Construccion Y Tecnologia*, 1990, VII, N20, pp. 7-16.
20. **Shaw**, W.J.D., "*The Role of Microsuperplastic Flow in High Temperature Fracture of AL-9021 Mechanically Alloyed Aluminum*", *J. of Materials Science Letters*, 1989, V24, pp. 4114-4119.
21. El-Rahman, M.A. and **Shaw**, W.J.D., "*Computers in Concrete Technology*", *Concrete International: Design and Construction*, 1989, V11, N8, pp. 27-31.
22. **Shaw**, W.J.D., "*Gas Evolution and Analysis from Mechanically Alloyed IN-9021*", *Materials Letters*, 1987, Vol 6, No 3, pp.75-79.

23. **Shaw, W.J.D.**, "*Corrosion Behavior of IN-9021 Aluminum Alloy*", Corrosion, 1986, V42, N9, pp. 554-556.
24. **Shaw, W.J.D.**, "*Creep Crack Growth Fracture Morphology of IN-9021 Aluminum Alloy*", Metallography, 1986, V19, N3, pp. 335-343.
25. **Shaw, W.J.D.**, "*Fatigue Morphology of IN-9021 Aluminum Alloys*", Metallography, 1986, V19, N2, pp. 235-242.
26. **Shaw, W.J.D.**, "*Stress Corrosion Cracking Behavior of IN-9021 Aluminum Alloy*", Metallography, 1986, V19, N2, pp. 227-233.
27. **Shaw, W.J.D.**, "*Superplastic Behavior of Creep in IN-9021 Aluminum Alloy*", Micron, 1985, V16, N4, pp. 281-284.
28. **Shaw, W.J.D.**, "*Microsuperplastic Behavior*", Material Letters, 1985, V4, N1, pp. 1-4.
29. **Shaw, W.J.D.**, "*Microstructural Analysis of IN-9021 Aluminum Alloy*", Micron, 1985, V16, N3, pp. 179-182.
30. **Shaw, W.J.D.**, "*Fracture Toughness of IN-9021 Aluminum Alloy*", Metallography, 1985, V18, N4, pp. 405-412.
31. **Shaw, W.J.D. and Le May, I.**, "*Environment Fatigue Crack Propagation Interactions*", Canadian Met. Quarterly, 1984, V23, pp. 1-6.
32. **Shaw, W.J.D. and Le May, I.**, "*Segmented Fitting of Fatigue Crack Growth Data*", Fatigue of Engineering Materials and Structures, 1983, V6, pp. 367-375.
33. **Shaw, W.J.D. and Le May, I.**, "*Stress Ratio Effects in Fatigue Fracture Morphology in G41400 Steel*", Metallography, 1983, V16, pp. 403-411.
34. **Shaw, W.J.D. and Le May, I.**, "*Intrinsic Material Scatter in Fatigue Crack Propagation*", Fatigue of Engineering Materials and Structures, 1981, V4, pp. 367-375.
35. **Shaw, W.J.D.**, "*Nomograph Determines Moisture Addition, Removal Quantities*", Heating/Piping/Air Conditioning, 1974, V46, N2, pp. 53-54.
36. **Lambdon, T.L., Shaw, W.J.D. and Green, G.H.**, "*Heat Release from Alfalfa Leaf-Cutter Bees*", Canadian Agricultural Engineering, 1973, V15, N2, pp. 110-112.

37. **Shaw, W.J.D.**, *"Nomograph Determines BHP Required to Pump Any Fluid"*, Heating/Piping/Air Conditioning, 1973, V45, N12, pp. 69-70.
38. **Shaw, W.J.D.**, *"Nomograph Gives Flow of Any Heat Transfer Fluid"*, Heating/Piping/Air Conditioning, 1972, V44, N11, pp. 101-102.
39. **Shaw, W.J.D.**, *"Chart Centerline Velocity for Inlet from Unconfined Spaces"*, Heating/Piping/Air Conditioning, 1971, V43, N8, pp. 85-86.

#### CONFERENCE PUBLICATIONS:

40. **Shaw, William J.D.**, and Andersson, Jan I., *"Atmospheric Corrosion of Carbon Steel in the Prairie Regions"*, NACE 2010 Western Region Conference, pp. 1-19.
41. Schwarz-Tonhauser, M. and **Shaw, W.J.D.**, *"Detailed Analysis of USA OPS Onshore Natural gas Gathering Database, 1985-July 2006"*, 1st International Pipeline Integrity Conference, BHR group, Schipol, the Netherlands, 2008, November, pp. 1-14.
42. Senadheera, T.D.A.A. and **Shaw, W.J.D.**, *"Important Practical Aspects of Equipment Development required for the Synthesis of a New Alloy"*, CSME forum 2006, Proceedings, May 21-24, 2006, Kananaskis, Alberta, editor, J. Pieper, pp. 1-16.
43. **Shaw, W.J.D.**, *"Correlations Between Direct and Indirect Electrochemical Measurement Methods of Determining Hydrogen Quantities in Steel"*, NACE, 2003, Western Region Conference, pp. 1-13.
44. **Shaw, W.J.D.** and Hu, S., *"Superplastic Mechanical and Mechanistic Behavior of Mechanically Alloyed AL-9021 Aluminum"*, ASM-TMS, 2002, pp. 1-22.
45. **Shaw, W.J.D.**, *"Alterations to Polyurethane Material by the Addition of Mechanically Alloyed Rubber"*, PRICM4, Vols I & II, 2001, pp. 159-162.
46. **Shaw, W.J.D.** and Fraser, M.A., *"Sn/Bi Solder Element Map Comparisons Between a Supermicroprobe and a Standard SEM EDS System"*, IUMAS 2000, Inst. Phys.Conf. Ser.No. 165: Symposium 14, 2000, pp. 457-458.
47. **Shaw, W.J.D.**, Matei, D., and Fraser, M.A., *"Understanding the Behavior of the Vacuum Foil Hydrogen Permeation Technique"*, NACE Corrosion 2000, 2000, paper # 00463, pp. 463/1-463/11.
48. **Shaw, W.J.D.**, Fraser, M.A. and Nijjar, T.S., *"Effects of Reaging 2024-T3 and 7075-T6 Aluminum Alloys on the Microstructure and Mechanical Properties"*, Microstructural

Science, ASM, 1999, V26, pp. 269-276.

49. **Shaw, W.J.D., Fraser, M.A. and Danilkevich, H.J.,** *"Material Characterization of Polystyrene/Tin and Polypropylene/Aluminum Mechanical Alloys"*, The third Pacific rim International Conference on Advanced Materials and Processing, (PRICM3), ed's., M.A. Imam, R. DeNale, S.Hanada, Z. Zhong and D.N. Lee, V1, TMS, 1998, pp. 525-530.
50. **Shaw, W.J.D., Jayasinghe, D.M. and Matei, D.G.,** *"Correlations Between Corrosion, Electrochemical Hydrogen Flux and a Vacuum Foil Technique"*, NACE Corrosion 98, 1998, paper #391, pp. 391/1-391-12.
51. **Shaw, W.J.D., Bizon, A. And LeBlanc, T.,** *"Parameters Affecting Electrochemical Hydrogen Permeation Measurements"*, NACE Corrosion 98, 1998, paper #392, pp. 392/1-392/13.
52. **Shaw, W.J.D. and Danilkevich, H.J.,** *"Microstructural Characterization of a Polymer/Metal Mechanical Alloy"*, Microstructural Science, ASM, V 25, 1998, pp. 297-302.
53. **Shaw, W.J.D.,** *"Current Understandings of Mechanically Alloyed Polymers"*, Materials Science Forum, Vols 269-272, Trans Tech Publications, Switzerland, 1998, pp. 19-30.
54. **Shaw, W.J.D., Gunea, I.A. and Kuhn, M.** *"Understandings Microsuperplasticity in Mechanically Alloyed Aluminum"*, Inelasticity and Damage in Solids Subject to Microstructural Change, ed's., I.J. Jordaan, R. Seshadri and J.L. Maglis, 1997, pp. 123-132.
55. **Gavrilov, D., Vinogradov, O., Shaw, W.J.D.,** *"Simulation of Mechanical Alloying in a Shaker Ball Mill with Variable Size Particles"*, Proceedings Composite Processing and Microstructure, Queensland, Australia, Ed. M.L. Scott, pp. 370-378, July 1997
56. **Shaw, W.J.D., I.A. Gunea and M. Kuhn,** *"Understanding Microsuperplasticity in Mechanically Alloyed Aluminum"*, Proceedings of Inelasticity and Damage in Solids Subject to Microstructural Change, St. John's, NF, Canada, September 1996, in press.
57. **Gavrilov, D., Vinogradov, O. and Shaw, W.J.D.,** *"Computer Simulation of Mechanical Alloying in a Shaker Ball Mill"*, Proceedings of the Tenth International Conference on Composite Materials, ICCM-10, Whistler, B.C. Canada, August 1995, pp. III.11 -III.17.
58. **Pan, J. and Shaw, W.J.D.,** *"Characterization of a Mechanical Alloyed PA/ABS*

- Polymeric Material*", Microstructural Science, ed's C.R. Brooks & M.R. Louthan, Jr., ASM, 1994, V21, pp. 95-106.
59. Depiak, A.M. and **Shaw**, W.J.D., "*Comparative Material Characterization Techniques for Determination of Retained Austenite*", Microstructural Science, ed's C.R. Brooks & M.R. Louthan, Jr., ASM, 1994, V21, pp. 235-242.
  60. Sun, C., **Shaw**, W.J.D. and Vinogradov, A.M., "*Buckling of Circular Rings Confined Within Rigid Boundaries*", Materials and Design Technology, ed. T.J. Kozik, ASME, 1994, PD-Vol. 62, pp. 219-224.
  61. **Shaw**, W.J.D. and Gowler, M.A., "*High Elastic Modulus Engineered Polymeric/Ceramic Mechanical Alloy*", Processing Materials for Properties, ed's. H. Henein and T. Oki, TMS, 1993, pp. 687-690.
  62. **Shaw**, W.J.D., Pan, J. and Gowler, M.A., "*Property Relationships of Some New MA Polymers*", 2nd International Conference on Mechanical Alloying for Structural Applications, ed's. J.J. deBarbadillo, F.H. Froes and R. Schwarz, ASM, 1993, pp. 431-437.
  63. Danilekewich, H.J., **Shaw**, W.J.D., and Kozdras, M.S., "*Corrosion Properties of Mechanically Alloyed Aluminum*", Light Metals Processing and Applications, ed's. C. Bickert, M. Bouchard, G. Davies, E. Ghali and E. Jiran, TMS, 1993, pp. 807-818.
  64. **Shaw**, W.J.D., Zhu, X. and Derry, R., "*Fatigue Crack Propagation Rates as Effected by Various Conditions of Surface Residual Stress*", Fatigue 93, ed's. J.-P. Bailon and J.I. Dickson, Vol. II, EMAS, 1993, pp. 699-705.
  65. **Shaw**, W.J.D., "*Characterization of Weld Microstructure in 2024 Aluminum Alloy*", Microstructural Science, ed's. W.R. Kanne, Jr., G.W.E. Johnson, J.D. Braun and M.R. Louthan, Jr., ASM, 1993, V20, pp. 17-29.
  66. Pan, J. and **Shaw**, W.J.D., "*Materials Characterization of Polyamide/Polyethylene Mechanically Alloyed Polymer*", Microstructural Science, ed's. W.R. Kanne, Jr., G.W.E. Johnson, J.D. Braun and M.R. Louthan, Jr., ASM, 1993, V20, pp. 351-365.
  67. **Shaw**, W.J.D., "*Metallography of Mechanically Alloyed Aluminum*", Metallography: 75 Years Later, ed's. G.F. VanderVoort, F.J. Warmuth, S.M. Purdy and A. Szirmai, ASTM STP 1165, 1993, pp. 344-362.
  68. Pan, J. and **Shaw**, W.J.D., "*Properties of Mechanically Processed Polymeric Materials*", New Materials and Processes for the Future, ed's. T.S. Reinhart, M.

Rosenow, R.A. Cull and E. Struckholt, SAMPE, 1992, V24, pp. T762-T775.

69. **Shaw, W.J.D.,** Huang, H., Diakow, D.A., and Szklarz, K.E., *"Required Environmental Test Procedures for Making Representative Materials Service Evaluations"*, Materials Performance: Sulphur and Energy, ed's. P.R. Roberge, K. Szklarz and V.J. Sastri, CIM, 1992, pp. 195-207.
70. Pan, J. and **Shaw, W.J.D.,** *"Microstructure of Mechanically Processed Polymeric Materials"*, Microstructural Science, ed's. D.A. Wheeler, G.W.E. Johnson, D.V. Miley and M.R. Louthan, Jr., ASM, 1992, V19, pp. 659-669.
71. Diakow, D.A. and **Shaw, W.J.D.,** *"Stress Corrosion Cracking Fractography of a High Strength Low Alloy Casing Steel Exposed to a Sour Gas Environment"*, Microstructural Science, ed's. D.A. Wheeler, G.W.E. Johnson, D.V. Miley and M.R. Louthan, Jr., ASM, 1992, V19, pp. 251-264.
72. Huang, H. and **Shaw, W.J.D.,** *"Fractographic Analysis: Sulfide Stress Cracking of Mild Steel Exposed to a Sour Gas Environment"*, Microstructural Science, ed's. D.A. Wheeler, G.W.E. Johnson, D.V. Miley and M.R. Louthan, Jr., ASM, 1992, V19, pp. 265-275.
73. **Shaw, W.J.D.,** *"Effects of Prior Fatigue Damage on Crack Propagation Rates in 2024-T351 Aluminum Alloy"*, Aeronautical Fatigue: Key to Safety and Structural Integrity, ICAF91, ed's. A. Kobayashi, EMAS, 1991, pp. 317-334.
74. **Shaw, W.J.D.,** *"Microsuperplasticity in Aluminum Alloys"*, Hot Deformation of Aluminum Alloys, ed's. T.G. Langdon, H.D. Merchant, J.G. Morris and M.A. Zaidi, TMS, 1991, pp. 277-296.
75. **Shaw, W.J.D.,** *"Failure Analysis of a Spoon Broken by a Parapsychic Person"*, Microstructural Science, ed's. T. A. Place, J.D. Braun, W.E. White and G.F. Vander Voort, ASM, 1990, V18, pp. 517-527.
76. **Shaw, W.J.D.,** *"Microstructural Evaluation of an Fe-30Mn-8Al Alloy Exposed to High Temperature Deformation"*, Microstructural Science, ed's. T. A. Place, J.D. Braun, W.E. White and G.F. Vander Voort, ASM, 1990, V18, pp. 269-280.
77. **Shaw, W.J.D.,** *"Strain-Life Fatigue Characteristics of Mechanically Alloyed AL 9021 Aluminum Alloy"*, Fatigue 90, ed's. H. Kitagawa and T. Tanaka, MCEP, 1990, V2, pp. 979-984.
78. **Shaw, W.J.D.,** *"Microstructure/Mechanical Property Relations in a Mechanically Alloyed Aluminum"*, AGARD Conf. Proc. No. 444, New Light Alloys, Specialized Printing Service, 1989, pp. 23.1-23.12.

79. **Shaw, W.J.D. and Jayasinghe, D.M.**, *"Corrosion Comparison of Materials in a Simulated Coal Gasification Environment"*, Microstructural Science, ed's. P.J. Kenny, G.S. Cole, D.O. Northwood, J. Wylie and G.F. Vander Voort, ASM, 1989, V17, pp. 243-252.
80. **Shaw, W.J.D. and Rowell, R.E.**, *"Microstructure and Kinetically Induced Changes in a Mechanical Alloy"*, Microstructural Science, ed's. H.J. Cialone, G.W.E. Johnson, M.E. Blum and G.F. Vander Voort, ASM, 1988, V16, pp. 349-360.
81. **Shaw, W.J.D.**, *"Fatigue Evaluation of a Mechanically Alloyed Aluminum"*, New Materials and Fatigue Resistant Aircraft Design, ed. D.L. Simpson, EMAS, 1988, pp. 215-226.
82. **Shaw, W.J.D.**, *"Microsuperplasticity"*, Materials Week 87, Extended Abstracts, ASM 1987, pp. 226.
83. **Shaw, W.J.D.**, *"Integrated Analysis of an Autoclave Failure"*, Microstructural Science, ed's. M.E. Blum, P.M. French, R.M. Middleton, G.F. Vander Voort, ASM, 1987, V15, pp. 141-150.
84. **Shaw, W.J.D.**, *"Weldability of IN-9021 Aluminum Alloy"*, Microstructural Science, ed's. M.R. Louthan, Jr., I. Le May and G.F. Vander Voort, ASM, 1986, V14, pp. 17-27.
85. **Shaw, W.J.D.**, *"Aspects of Accelerated SCC Tests on Aluminum Alloys in 3.5% NaCl Solution"*, Microstructural Science, ed's. S.A. Shiels, C. Bagnall, R.E. Witkowski and G.F. Vander Voort, ASM, 1985, V13, pp. 565-581.
86. **Shaw, W.J.D.**, *"Surface Corrosion Comparisons of Some Aluminum Alloys in 3.5% NaCl Solution"*, Microstructural Science, ed's. D.O. Northwood, W.E. White and G.F. Vander Voort, ASM, 1985, V12, pp. 243-262.
87. **Shaw, W.J.D. and Le May, I.**, *"Fatigue Fracture Morphology of a High Strength Steel Exposed to Various Relative Humidities"*, Microstructural Science, ed's. R.T. DeHoff, J.D. Braun and J.L. McCall, Elsevier, 1983, V11, pp. 154-162.
88. **Le May, I. and Shaw, W.J.D.**, *"Fatigue Crack Growth Thresholds in G41400 Steel in Controlled Humidity Environments"*, Fatigue Thresholds, ed's. Backlund, Blom, Beevers, 1982, V2, pp. 603-614.
89. **Shaw, W.J.D.**, *"The Canadian Graduate Student Enrollment Crunch"*, Proceedings of the Third Canadian Engineering Education Conference, ed. G. Walker, 1982, pp. 349-364.

90. **Shaw, W.J.D. and Le May, I., "Fatigue Crack Propagation from Crack Arrays",** Advances in Fracture Research, ed., D. Francois, ICF5, 1981, V2, pp. 613-622.
91. **Shaw, W.J.D. and Le May, I., "Crack Closure During Fatigue Crack Propagation",** Fracture Mechanics, ASTM STP 677, 1979, pp. 233-246.
92. **Shaw, W.J.D. and Le May, I., "Fractographic Studies and Statistical Scatter in Fatigue Crack Propagation Under Controlled Humidity Conditions",** The Influence of Environment on Fatigue, I. Mech. E., 1977-4, pp. 93-100.
93. **Shaw, W.J.D. and Le May, I., "Fatigue Crack Propagation in High Strength Steel Under Controlled Humidity Conditions",** Fatigue Testing and Design, ed. R.D. Bathgate, Society of Environmental Engineers Fatigue Group, 1976, V2, pp. 31.1-31.24.
94. **Le May, I., Whelan, J.M. and Shaw, W.J.D., "Design for Fatigue in Notched High Strength Steel",** ASME paper no. 75-DE-31, 1975, pp. 1-12.
95. **Lui, M.W., Shaw, W.J.D., Whelan, J.M. and Le May, I., "A Comparison of Transition Zones on the Fracture Surfaces of High Strength Steels",** Microstructural Science, Elsevier, 1975, V3, pp. 3-20.

#### PATENTS:

96. **Shaw, W.J.D., "Polymer Material and Process for Production Thereof",** U.S.A., patent #5,874,521, February 23, 1999.
97. **Shaw, W.J.D., "Polymer Alloy Material and Process for Production Thereof",** Canadian patent # 2,071,707 April 22, 1997.
98. **Shaw, W.J.D., "Polymer Alloy Material and Process for Production Thereof",** U.S.A. patent # 5,367,048 November 22, 1994.

#### Major University Generated Reports:

99. **Shaw, W.J.D., "Investigation of Hydrogen Embrittlement Failures of Torsion Bars",** Final report, ArvinMeritor, February 24, 2009, pgs 131.
100. **Shaw, W.J.D. and Schwarz-tonhauser, M., "JIP Batch Inhibitor Review",** Final report, consortium of 8 companies, November 3, 2008, pgs 93.
101. **Shaw, W.J.D. and Vargas, R., "Review & Analysis of Ring-Expansion Testing",** Final



- report, Kinder Morgan, June 20, 2007, pgs 47.
102. **Shaw, W.J.D.**, *"Benchmarking Fundamentals and Methods, Benchmarking on the Leaks Classification in Gathering Pipelines"*, project: Benchmarking on the Transmission and Gathering Pipelines Leaks and Ruptures of the Oil Industry, by PEC for IMP-PEMEX, Deliverable #1, September, 2006, pgs 94.
  103. **Shaw, W.J.D.**, *"Benchmarking on the Leaks Classification in Transport Pipelines"*, project: Benchmarking on the Transmission and Gathering Pipelines Leaks and Ruptures of the Oil Industry, by PEC for IMP-PEMEX, Deliverable #2, September, 2006, pgs 81.
  104. **Shaw, W.J.D.**, *"Current Technologies on Inspection, Detection and Repairing under Canadian and International Standards"*, project: Benchmarking on the Transmission and Gathering Pipelines Leaks and Ruptures of the Oil Industry, by PEC for IMP-PEMEX, Deliverable #3, October, 2006, pgs 95.
  105. **Shaw, W.J.D.**, *"Leaks Impact on the Environment, Economy, Policies and Image of Pipeline Companies"*, project: Benchmarking on the Transmission and Gathering Pipelines Leaks and Ruptures of the Oil Industry, by PEC for IMP-PEMEX, Deliverable #4, November, 2006, pgs 157.
  106. **Shaw, W.J.D.**, *"Evaluation on Leaks Mitigation Strategies and Environmental Remediation"*, project: Benchmarking on the Transmission and Gathering Pipelines Leaks and Ruptures of the Oil Industry, by PEC for IMP-PEMEX, Deliverable #5, December, 2006, pgs 68.
  107. **Shaw, W.J.D.**, *"The Way Forward, Comparative Parameters From Leaks, Ruptures and Risk Assessments"*, project: Benchmarking on the Transmission and Gathering Pipelines Leaks and Ruptures of the Oil Industry, by PEC for IMP-PEMEX, Deliverable #6, December, 2006, pgs 33.
  108. **Shaw, W.J.D. and Matei, D.G.**, *"Limits and Correlations of vacuum Induced Hydrogen flux in Corrosive Environments"*, Final report, Diversity Corporation, September 2000 pgs 46.
  109. **Shaw, W.J.D.**, *"Initial Exploratory Research into Coating Development by Utilizing the Mechanical Alloying Technique"*, Final report, Recycled Solutions for Industry, October, 1999, pgs 84.
  110. **Shaw, W.J.D. and Matei, D.G.**, *"Fundamental and Applied Studies of Hydrogen Embrittlement"*, Third year Final report, Alberta Energy, CANMET, Nova Corporation, Mobil Oil, Interprovincial Pipeline, Sask Energy, Shell Canada, Foothills Pipelines, Syncrude Canada, Chevron Research Ltd, September 1998, pgs 55.

111. Matei, D.G. and **Shaw**, W.J.D., "*Hydrogen Diffusivity in Materials*", Special report as part of Van Horne Institute and Fundamental and Applied Studies of Hydrogen Embrittlement, November 1998, pgs. 107.
112. **Shaw**, W.J.D. , "*Fundamental and Applied Studies of Hydrogen Embrittlement*", Second year Final report, Alberta Energy, CANMET, Nova Corporation, Mobil Oil, Interprovincial Pipeline, Sask Energy, Shell Canada, Foothills Pipelines, Syncrude Canada, Chevron Research Ltd, October 1997, pgs 50.
113. **Shaw**, W.J.D., "*Fatigue Life Improvement Approach of Composite NGV fuel Tanks*", Final report for Dynetek Industries Ltd, August 1997, pgs. 52.
114. Matei, D.G. and **Shaw**, W.J.D., "*Hydrogen Permeation Conversions and Equivalency Factors*", Special report as part of fundamental and Applied Studies of Hydrogen Embrittlement, May 1997, pgs. 39.
115. **Shaw**, W.J.D. and Bizon, A., "*Fundamental and Applied Studies of Hydrogen Embrittlement*", First year Final report, Alberta Energy, CANMET, Nova Corporation, Mobil Oil, Interprovincial Pipeline, Sask Energy, Shell Canada, Foothills Pipelines, Syncrude Canada, June 30, 1996, pgs 93.
116. **Shaw**, W.J.D. and Mao, X., "*Stress Corrosion Cracking of Materials in a Coal Gasification Environment*" Final report, CANMET, Nova Scotia Natural Resources, March 18, 1996, pgs 83.
117. **Shaw**, W.J.D., "*Exploratory Study for the Production of Titanium Carbide by Mechanical Alloying of Coal*", Final report, CANMET, November 30, 1995, pgs 44.
118. **Shaw**, W.J.D., "*Evaluation of the Effects of Long time Exposure at 200F and 400F on the Fatigue and crack Growth Characteristics of Aluminum Alloy Panels*", Final report, 55SS.31946-8-0016, National Aeronautical Establishment, Ottawa, March 31, 1992, pgs 84.
119. **Shaw**, W.J.D., "*Mechanical Alloy Polymers*", Final technical report, Natural Sciences and Engineering Research Council, Institute for Chemical Science and Technology, November 9, 1992, pgs 110.
120. **Shaw**, W.J.D. and Rowell, R.E., "*Corrosivity of Well waters Throughout Alberta*", Final report, Alberta Environmental Research Trust, May 31, 1988, pgs 70.
121. **Shaw**, W.J.D. and Rowell, R.E., "*Effect of Environment on the Interlaminar Shear Properties of High Strength Fiber Composites*", Final report, DREP Victoria, October, 1987, pgs 94.

122. **Shaw, W.J.D. and Geppert, N.S.**, *"Interlaminar Shear Measurement Techniques in ASI/3501-6 Composite Material"*, Final report, DREP Victoria, August, 1985, pgs 125.

Major Consulting Generated Reports:

123. **Shaw, W.J.D.**, *"Hardisty Atmospheric Corrosion Monitoring Program"*, Report #1, Husky Oil Operations Ltd, October 31, 2007, pgs 15.
124. **Shaw, W.J.D.**, *"Atmospheric Corrosion Theory and Understanding"*, Report #2, Husky Oil Operations Ltd, January 3, 2008, pgs 26.
125. **Shaw, W.J.D.**, *"Expected Atmospheric Corrosion of Steel Tanks at Hardisty Terminal"*, Report #3, Husky Oil Operations Ltd, January 15, 2008, pgs 13.
126. **Shaw, W.J.D.**, *"Fatigue Analysis Report, Deh-Cho Bridge Across the MacKenzie River, Yellowknife Highway #3, Northwest Territories"*, J.R. Spronken & Associates Ltd, March 14, 2005, pgs 16.
127. **Shaw, W.J.D.**, *"Ortovox transceiver Investigation"*, RCMP Nelson, B.C., July 27, 2005, pgs 11.
128. **Shaw, W.J.D.**, *"Corrosion Materials Screening Study, THAI Recovery Project"*, Orion Oil Canada Ltd., June 8, 2004, pgs 24.
129. **Shaw, W.J.D.**, *"Investigation into Upward Curvature of Sulfur Converters at KA"*, Central Alberta Midstream, January 10, 2004, pgs 32
130. **Shaw, W.J.D.**, *"Evaluation of Expander Inlet Line 8P8092-42"*, Petro Canada Refinery, June 30, 2003, pgs 22.
131. **Shaw, W.J.D.**, *"Galvanize Coating Analysis of Nexus Metal Pan"*, Final report, SMED International, November 14, 2001, pgs 18.
132. **Shaw, W.J.D.**, *"Floor Panel Adhesive Bond Evaluation"*, Final report, SMED International, June 14, 2001, pgs 33.
133. **Shaw, W.J.D.**, *"Safety Aspects of Coiled Pipe Storage Vessel vs Moderate Sized Pressure Vessels"*, Summary on Safety Aspects report, Enron Corp, Houston, Texas, U.S.A., August 20, 1996, pgs 16.
134. **Shaw, W.J.D.**, *"An Investigation of the Effect on Materials of Hydrogen in Natural Gas Vehicle Fuel"*, Final report, Canadian Gas Association, project NGV 200-5.20, January 31, 1993, pgs 79.

135. **Shaw, W.J.D.**, *"Sechelt Substation/Gas Pipeline Dispute"*, Final report, Province of British Columbia, March 30, 1993, pgs 90.
136. **Shaw, W.J.D.**, *"Inhibitor Screening Tests for Downhole and Pipeline Material in Sour Gas Aqueous Environments"*, Final report, Petro Canada, Calgary, February 7, 1985, pgs 195.
137. **Shaw, W.J.D.**, *"Inhibitor Screening Tests etc"*, Addendum, Petro Canada, Calgary, June 4, 1985, pgs 47.
138. **Shaw, W.J.D.**, *"SSDC Foam Pad and Adhesive Tests"*, Final report, Dome Petroleum, Calgary, May 31, 1983, pgs 94.
139. **Shaw, W.J.D.**, *"Defect Evaluation of HF Modified Tee"*, Final report, NewGrade Energy Inc., Regina, Saskatchewan, June 15, 1994, pgs 38.
140. **Shaw, W.J.D.**, *"Evaluation of the Safety Aspects of Cracked Lugs in High Pressure Heaters"*, Final report, Newfoundland and Labrador Hydro, St. Johns, NF, December 15, 1996, pgs 19.
141. **Shaw, W.J.D.**, *"Definition of Corrosion, Hydrogen Embrittlement and Inter-Relationships"*, Final report, Foothills Pipelines Ltd, Calgary, AB, May 1996, pgs 12.
142. **Shaw, W.J.D.**, *"Evaluation of Ameron Coating in Comparison to IC531 Coating"*, Final report, International Utility Structures Inc, Calgary, AB, September 1996, pgs 14.
143. **Shaw, W.J.D.**, *"Sandblasting Parameter Effects on Coatings of IC531"*, Final report, International Utility Structures Inc, Calgary, AB, May 1995, pgs 11.
144. **Shaw, W.J.D.**, *"Evaluation of Steam Accumulator Explosion"*, Final report, ECE Group Ltd, Toronto, ON, July 1993, pgs 14.